College of Arts & Sciences / The Ohio State University / Department of Psychology

Characterizing the Effect of Premature Birth on Adolescent Brain Network Organization

Emily Yu, Fiona Molloy, Whitney Mattson Ph.D., Gerry Taylor Ph.D., Eric Nelson Ph.D., Zeynep Saygin Ph.D.

BACKGROUND

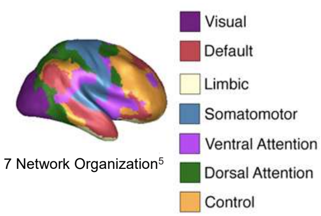
- Children born preterm score lower on neurocognitive tests from infancy to late adulthood compared to those born full-term[3]
- There exist brainwide differences between premature and full-term infants:
  - Structure: decreased volumes of cortical GM, deep nuclear GM, and myelinated WM in premature infants[4]
  - Functional Connectivity: at 36 months, full term born children have stronger connectivity in RSNs compared to former premature children[2]
  - Structural Connectivity: exhibit reduced FA in centrum semiovale, frontal white matter, and the genu of the corpus callosum in premature infants[1]

RESEARCH QUESTION

How does premature birth alter broadscale network organization later in life?

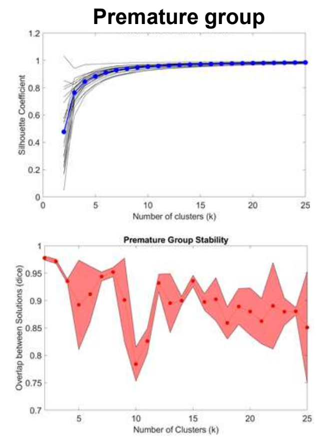
METHODS

- 22 prematurely born adolescents (mean scan age = 13.86 Years; age range = 11.43 to 16.93 years) and 28 full-term adolescents (mean scan age = 13.84 Years; age range = 11.17 to 16.74 years)
- Calculated individual connectomes using voxel-to-voxel correlations of resting-state fMRI data.
- Evaluated group-level solutions for the premature and full-term groups using fit to data and stability
- Ran the k-means algorithm along a sequence of networks ranging from 2 to 25

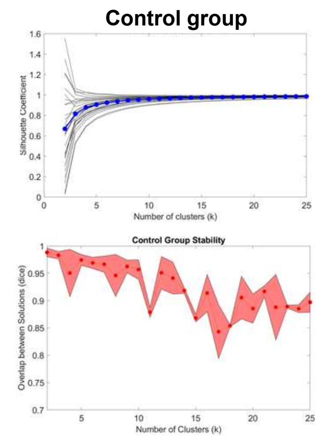


Adult 7 Network Organization[5]

Choosing optimal cluster solutions



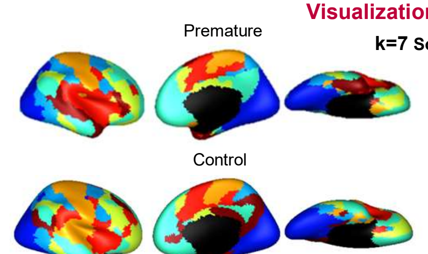
Optimal solutions for premature group:
k=
- 7
- 8
- 12
- 15

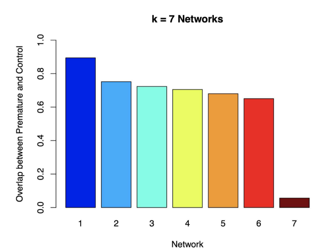


Optimal solutions for control group:
k=
- 5
- 6
- 7
- 9
- 12
- 16

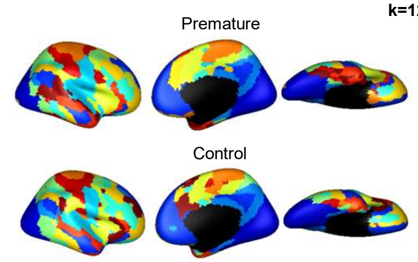
Visualization of clusters

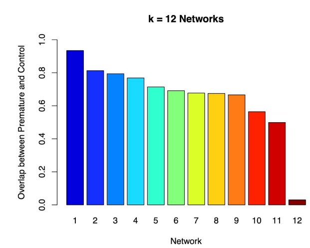
k=7 Solution



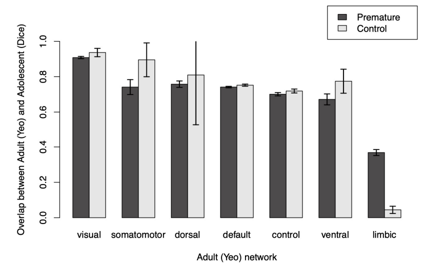


k=12 Solution





Overlap Between Adult and Adolescent 7-network Solutions



CONCLUSIONS

- The optimal k = 7 and k = 12 network solutions reveals differences in the premature group into adolescence.
- Adolescent brains show overall similarity to adults but with continued maturation particularly in the limbic network.
- The limbic network is more adult-like in premature adolescents than their full-term counterparts.
- Precocious development of the limbic network may play a role in negative neurocognitive outcomes that come with premature birth.

BIBLIOGRAPHY

1. Anjari, M., Srinivasan, L., Allsop, J. M., Hajnal, J. V., Rutherford, M. A., Edwards, A. D., & Counsell, S. J. (2007). Diffusion tensor imaging with tract-based spatial statistics reveals local white matter abnormalities in preterm infants. *NeuroImage*, *35*(3), 1021–1027. https://doi.org/10.1016/j.neuroimage.2007.01.035

2. Damaraju, E., Phillips, J. R., Lowe, J. R., Ohls, R., Calhoun, V. D., & Caprihan, A. (2010). Resting-state functional connectivity differences in premature children. *Frontiers in Systems Neuroscience*. https://doi.org/10.3389/fnsys.2010.00023

3. Heinonen, K., Eriksson, J. G., Lahti, J., Kajantie, E., Pesonen, A.-K., Tuovinen, S., Osmond, C., & Raikkonen, K. (2015). Late preterm birth and neurocognitive performance in late adulthood: A birth cohort study. *Pediatrics*, *135*(4). https://doi.org/10.1542/peds.2014-3556

4. Inder, T. E., Warfield, S. K., Wang, H., Hüppi Petra S, & Volpe, J. J. (2005). Abnormal cerebral structure is present at term in premature infants. *Pediatrics*, *115*(2), 286–294. https://doi.org/10.1542/peds.2004-0326

5. Yeo, B. T., Krienen, F. M., Sepulcre, J., Sabuncu, M. R., Lashkari, D., Hollinshead, M., Roffman, J. L., Smoller, J. W., Zöllei, L., Polimeni, J. R., Fischl, B., Liu, H., & Buckner, R. L. (2011). The organization of the human cerebral cortex estimated by intrinsic functional connectivity. *Journal of neurophysiology*, *106*(3), 1125–1165. https://doi.org/10.1152/jn.00338.2011

ACKNOWLEDGEMENTS

Emily Yu acknowledges funding from the College of Engineering at Ohio State University.